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Aeronuatical Systems Div. ltr dtd 22 Dec 1971

FTC-TR-70-6

Improved LAPES Equipment and Techniques

Phase I Performance Evaluation of a Drogue Initiation Device

JAMES M. BLACK
CAPT. USAF
Project Engineer

TECHNICAL REPORT NUMBER 70-6
FEBRUARY 1970

AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

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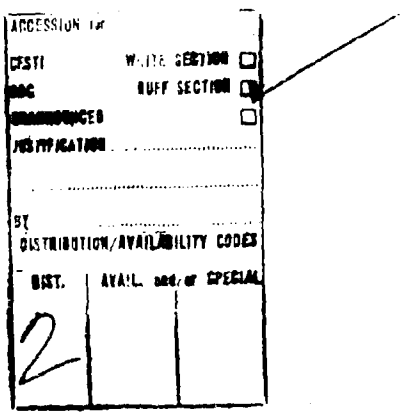

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FOREWORD

Testing was requested by the Adverse Weather Aerial Delivery Systems Program Office (AWAD SPO), Air Force System Command, Wright-Patterson AFB,Ohio, in a letter dated 27 March 1969. The test program was authorized by Air Force Flight Test Center Project Directive No. 70-34 and documented as Program Structure No. 152802, AFSC Priority 18B. This test program was identified locally as Line Item Code (LIC) 4131.

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ABSTRACT

This report presents information obtained during the test and evaluation of a drogue initiation device. The drogue initiation device tested was designed and manufactured for the Adverse Weather Aerial Delivery Systems Program Office by the Oxford Corporation of Buffalo, NY. Data were obtained during tow tests and release tests of a drogue parachute using the drogue initiation device mounted in a C-130 aircraft flying at 2000 ft MSL altitude and at an indicated airspeed of 110 or 150 knots. Twenty-two tests were conducted. Parachute drag forces were measured and drogue initiation device functional characteristics were observed. The drogue initiation device functioned satisfactorily on all tests. Minor equipment modifications are recommended to improve the operational effectiveness of the test item. Conditions which could limit the test items operational capability are cited.

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INTRODUCTION

PURPOSE

The purpose of the test program is to evaluate the equipment and techniques for the Improved Low Altitude Parachute Extraction System (LAPES).

SCOPE

This report covers Phase I of a four-phase test program. Twenty-two tests were made from a C-130 aircraft. Tests were made to evaluate: the emergency release, the electrical force transfer, and the manual force transfer functions of the drogue initiation device (DID).

TEST ITEM

The test item was a drogue initiation device designed and manufactured for the AWAD SPO by the Oxford Corporation of Buffalo, New York under AFSC contract No. F33657-69-C-0143.

The DID, Oxford Corporation part number (P/N) 7080-1, was comprised of a ramp-mounted tow plate (Figure 1) with force transfer link (Figure 2) and loadmaster station controller (Figure 3) with the associated cables and electrical leads. The DID is an electro-mechanical device which was designed to perform the following functions when used as part of LAPES: (a) retain the drogue parachute in tow, (b) transfer the force of the drogue parachute, by remote command, to deploy the extraction parachute(s), and (c) release the drogue parachute at any time prior to force transfer by remote command without effecting a force transfer to deploy the extraction parachute(s).

In normal operation, drogue parachute force transfer is accomplished electrically by energizing the tow plate soleniod. The switch used for this purpose is located on the assisted take-off (ATO) control panel and is activated by the aircraft co-pilot. An indicator lamp on the load extraction outlet (LEO) box, located in the cargo compartment, illuminates when the co-pilot activates the ATO control panel switch.

Manual operation of the DID is controlled by two levers from the loadmaster controller station, located at the loadmaster station just aft of the cargo compartment bulkhead. One control lever releases the drogue parachute without effecting force transfer to deploy the extraction parachute(s) (emergency release). The second control lever transfers the drogue parachute force to deploy the extraction parachute(s).

SUPPORT EQUIPMENT

AIRCRAFT

A C-130 cargo-type aircraft was used on all tests.

PARACHUTE

A 15-ft nominal diameter (D_o) ringslot (RS) parachute, P/N 57J6032, and a 60-ft-long, 2-ply, Type X, extraction line was used as the drogue parachute system on all tests.

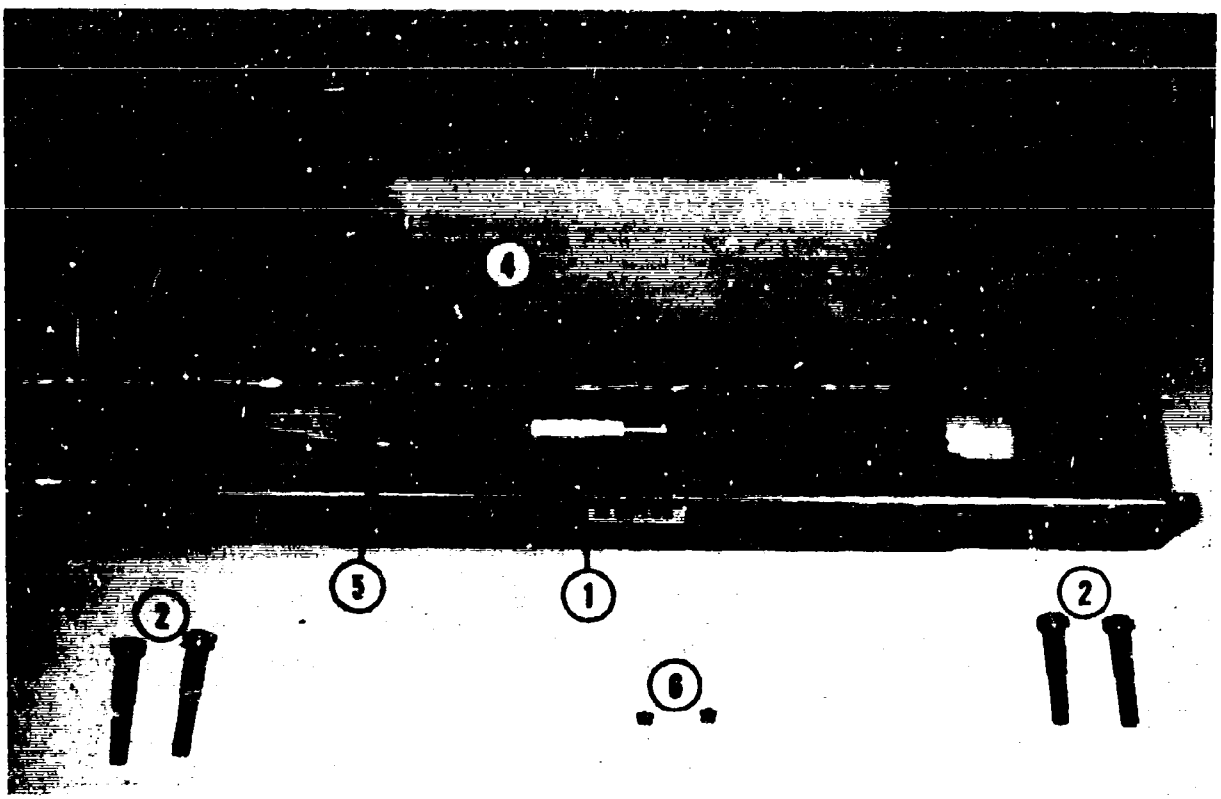
DATA ACQUISITION

TEST DATA

Test data were obtained using electronic and optical methods and were recorded on a common time base.

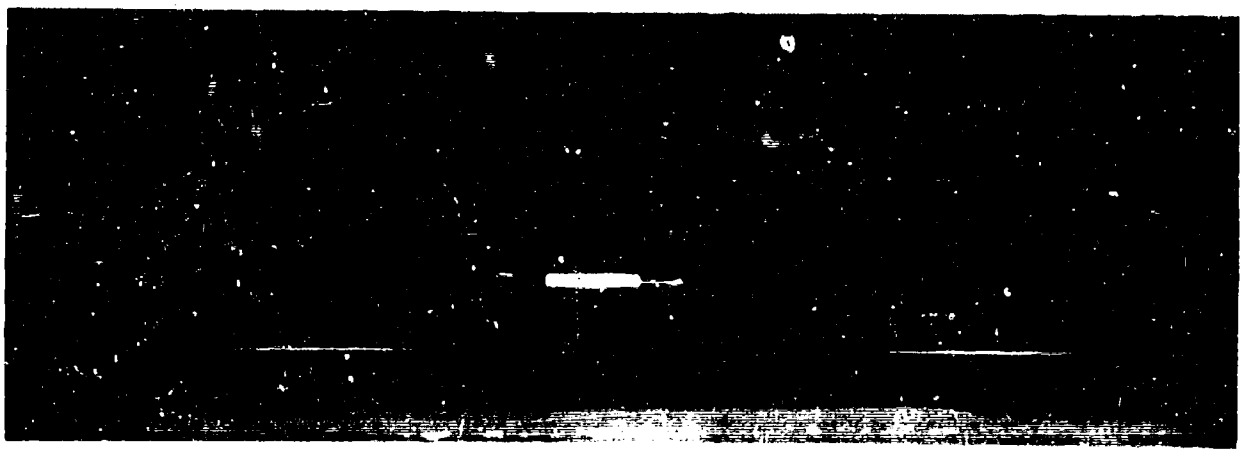
TELEMETRIC EQUIPMENT

Telemetric equipment was used to obtain forces and event times. Sensors mounted in the drogue line or on the test item fed signals to a telemetric transmitter mounted on the aircraft. The transmitted signals were received at a ground-based receiving station located near the drop zone. Signals were recorded on magnetic tape for subsequent playback and printout on oscillograms. The oscillograms were annotated with values of the forces at significant event times, using calibration signals received just prior to start of test.



1. SOLENOID 2. MOUNTING BOLTS 3. COVER
4. PUSH-PULL CABLE ATTACHMENT POINTS 5. SOLENOID ELECTRICAL RECEPTACLE
6. COVER MOUNTING SCREWS

Figure 1 Tow plate with Force Transfer Link and Cover Removed



1. MECHANICAL PUSH-PULL CABLES 2. ELECTRICAL CABLE 3. FORCE TRANSFER LINK

Figure 2 Tow plate with Cover Removed

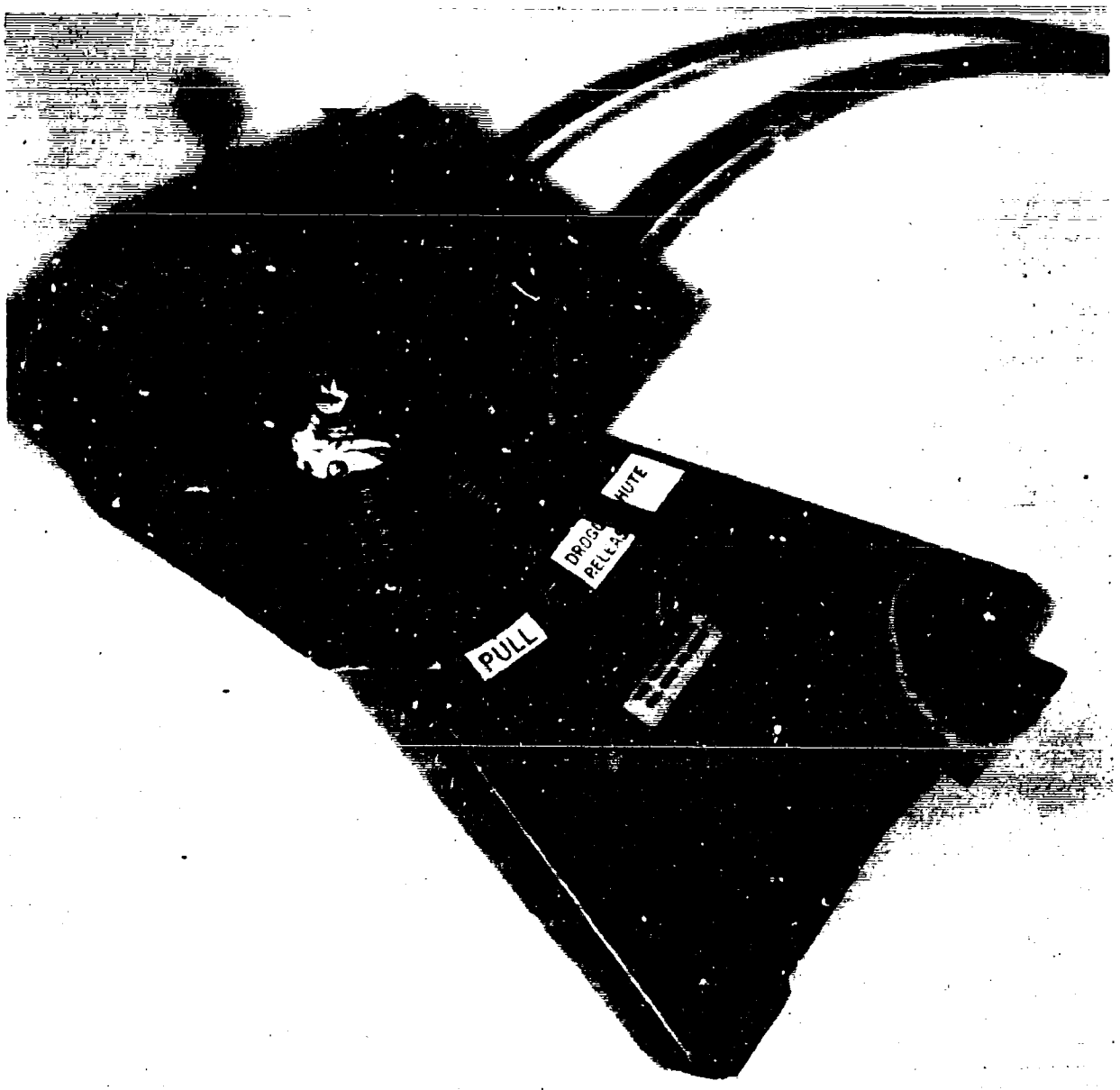


Figure 3 Loadmaster Station Controller

MOTION PICTURE COVERAGE

Ground- to-air and onboard 16mm cameras, with frame rates ranging from 100 to 200 frames per second, were used to obtain colored motion picture coverage.

TEST CONDITIONS AND PROCEDURES

TEST CONDITIONS

All tests were made from a C-130 aircraft flying at 110 or 150 KIAS and at 2000 ft MSL altitude.

INSTALLATION PROCEDURE

DID cosponent locations, in the cargo compartment of a C-130 aircraft are shown in Figure 4. The tow plate was located on the centerline of the aircraft and was attached to the third and fourth tiedown fittings aft of the ramp hinge line. The loadmaster station controller was mounted in place of cargo compartment tiedown ring B-3 (Figure 5). The mechanical push-pull cables were routed from the loadmaster station controller along the floor inboard to the aircraft centerline and then along the centerline aft to the tow plate. The electrical cable was routed forward from the tow plate along the centerline of the aircraft to the ramp hinge line then outboard to the left side of the aircraft and forward again past the paratroop door and vertically to the load extraction outlet box.

During the installation of the drogue initiation device in the aircraft the following deficiencies were noted:

a. The bolts provided to attach the tow plate to the aircraft ramp were not compatible with the aircraft, both in diameter and length.

b. The mechanical push-pull cables provided to connect the loadmaster controller station to the tow plate were approximately 2 ft too short when routed as specified in the manufacturer's installation instructions. (See Figure 4.)

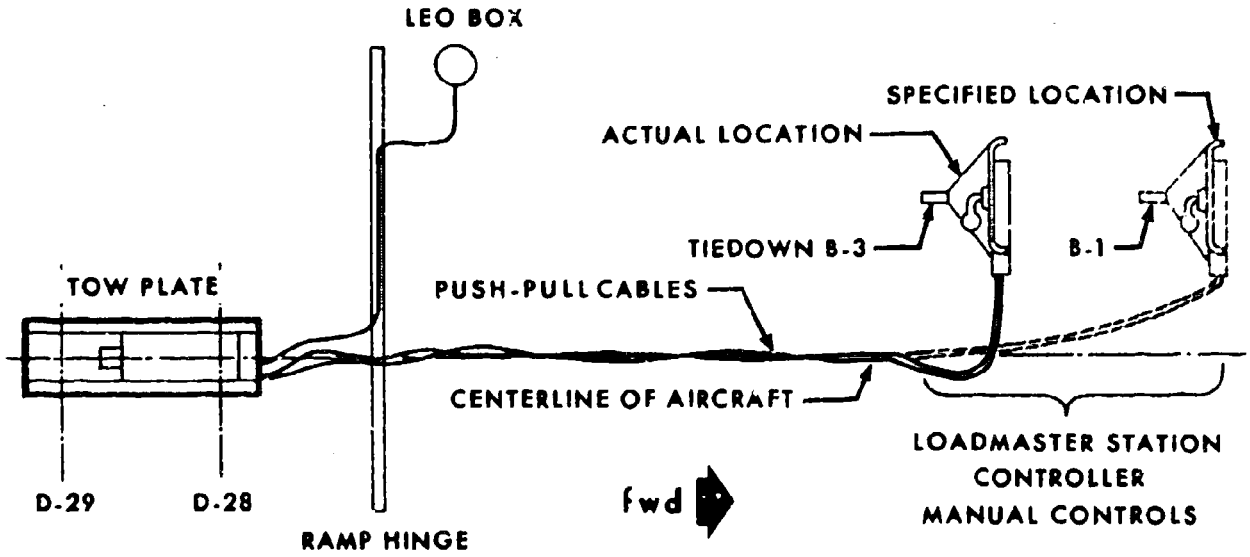


Figure 4 DID Component Locations

Figure 5 Loadmaster Station Controller Installed in the Specified Location

c. The five spare force transfer links provided with the test item were too long and would not lock into position.

TEST PROCEDURE

On all tests a 15-ft D_o RS parachute was deployed from the aircraft pendulum release system and towed from the tow plate. After approximately 10 sec of tow, the electrical transfer, the manual transfer, or the emergency release was activated.

TEST RESULTS

In addition to the deficiencies noted during installation of the DID, the following items were observed during testing of the DID:

a. The inside edges of the force transfer links had sharp edges which could chafe and cut the web lines.

b. The specified location of the loadmaster station controller interfered with the operation of the right-hand-rail emergency release lever.

c. During pre-flight checks the tow plate emergency release pin did not fully retract when operated manually. This prevented the force transfer link from releasing.

TEST RESULTS
DROGUE INITIATION DEVICE

Test No.	Indicated airspeed (kt)	Function tested	Drogue force at release (lb)
1998F69	110	Emergency release	4800
1999F69	110	Emergency release	4150
2000F69	110	Emergency release	4750
2001F69	110	Emergency release	4950
2002F69	110	Emergency release	4550
2003F69	150	Electrical force transfer	8800
2004F69	150	Electrical force transfer	8500
2005F69	150	Electrical force transfer[1]	8825
2006F69	150	Electrical force transfer	8450
2007F69	150	Electrical force transfer[1]	8750
2182F69	150	Electrical force transfer	(2)
2183F69	150	Electrical force transfer	7900
2008F69	150	Emergency release	(2)
2009F69	150	Emergency release	8000
2010F69	150	Emergency release	7950
2011F69	150	Emergency release	8225
2012F69	150	Emergency release	8400
2184F69	110	Manual force transfer	5050
2185F69	110	Manual force transfer	4700
2186F69	110	Manual force transfer	4750
2187F69	110	Manual force transfer	4740
2188F69	110	Manual force transfer	4600

1. Aircraft electrical problems not associated with the drogue initiation device were encountered. Manual force transfer was accomplished.

2. Telemetric equipment malfunctioned.

d. The loadmaster had difficulty determining when the electrical force transfer had been initiated.

e. The loadmaster station controller levers were not securely fastened to the shafts which activate the mechanical push-pull cables. During pre-flight checks it was found that the drogue emergency release lever could be rotated without actuating the release mechanism in the tow plate.

f. The tow plate cover was dented when hit by a deploying extraction line.

Results of tests conducted on the drogue initiation device are presented on page 6.

CONCLUSIONS

The DID functioned satisfactorily on all tests. On two of the tests aircraft electrical problems were encountered and the DID manual release was used. On these two tests the manual release functioned satisfactorily as a manual back-up system for the normal electrical activation of the DID.

RECOMMENDATIONS

The following recommendations are made to improve the physical characteristics and operational effectiveness of the drogue initiation device:

a. Tow plate mounting bolts AN5C-30A (forward) and AN5C-26A (aft) should be furnished and the tow plate modified for their use.

b. The loadmaster station controller should be relocated from the specified location to avoid obstructing the passageway and to avoid impeding the operation of the right-hand-rail emergency release lever.

c. Mechanical push-pull cables of sufficient length should be provided.

d. Force transfer link inside edges should be rounded. Force transfer links should be of uniform size.

e. Provide a means of preventing partial insertion of the drogue emergency release pin into the force transfer link. Partial insertion prevents the force transfer link from releasing.

f. The load extraction outlet box, when used with the DID, should be relocated adjacent to the loadmaster control station. This would allow the routing of the electrical cable along the centerline of the aircraft, avoiding the rollers and the ramp hinge. Relocation of the outlet box would also give the loadmaster an easily visible indication of the electrical actuation of the tow plate.

g. The control levers on the loadmaster station controller should be fastened more securely to their shafts to prevent the levers from rotating on their shafts.

h. The tow plate cover (Figure 1) should be reinforced along its lateral axis to preclude damage from external equipment.

COMMENTS

The design of the Oxford Corporation DID tow plate requires a vertical clearance above the tow plate to allow the force transfer link to rotate upward and release from the tow plate. The vertical clearance requirements are 4 3/8 inches to accomplish force transfer and 1 1/2 inches to accomplish drogue emergency release.

In the event a platform is inadvertantly released, prior to extraction parachute deployment, and moves aft in the aircraft to a position above the tow plate, the vertical clearance between the bottom of the platform and the tow plate may not be sufficient to allow force transfer or drogue chute release from the tow plate.

Under these conditions the DID would be rendered inoperable and the aircraft flight safety could be endangered.

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Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION
Air Force Flight Test Center	UNCLASSIFIED
	2b. GROUP N/A

3. REPORT TITLE

Improved LAPES Equipment and Techniques, Phase I, Performance Evaluation of a Drogue Initiation Device

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)

James M. Black

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
February 1970	11	None

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO. AFFTC Project Directive 70-34 LIC 4131	FTC-TR-70-6
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d.	None

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
None	6511th Test Group (Parachute) NAF El Centro, California 92243

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DD FORM 1 NOV 68 1473

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
C-130						
Drogue						
Drogue emergency release						
Drogue initiation device						
Electrical force transfer						
Loadmaster station controller						
Low altitude parachute extraction system						
Manual force transfer						